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Tests in artificial scallop seed collection

1967

by

O. Sato*, K. Yokoyama, H. Ogawa, H. Soyama, S. Ito

Foreword

~~In the context~~ As part of a project aimed at improving the coastal fisheries structure, the Aomori prefecture built a station for seed supply. The purpose was to carry out artificial seed collections of the most important shells (girl) found mainly in the Mutsu Bay (scallop, ark shell, abalone). The operations are now in progress. As a result of tests conducted this year for the purpose to achieve artificial mass collection of seed, we have at this point been able to gather 150,000 settled spats (scallop).

In spite of the many outstanding problems, we are reporting here on the results obtained so far.

However, we first want to express our gratitude to the personnel of the fishermen's cooperative in Kawauchi, Shimokata Township for helping us gather ~~the~~ adult scallop~~, mother shells~~.

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*or "T. Sato".

Materials and method

(1) Broood Stock ~~Mother shells~~

Adult ~~The~~ scallop, ~~mother shells~~ used in the tests were gathered ~~in~~ on 7 ~~times~~ occasions between February 15 and April 26, 1967 off Kawauchi, inside ~~the~~ Mutsu Bay at a depth of about 15 m. Each time, 30-50 ~~shells~~ adults were gathered.

We ~~performed spawning induction tests~~ attempted artificial spawning with these groups of ~~mother shells~~ adults through thermal stimulation, and examined the seasonal variations by measuring the maturity of the gonads

(gonad weight/soft parts weight x 100).

Using ~~shells~~ adults collected March 20, we performed artificial ~~fertilization~~ spawning and reared the fertilized eggs.

Some of the individuals collected March 20, April 12 were kept in a cooled tank ~~for spawning inhibition tests~~ to determine if spawning could be delayed.

(2) Method of inducing spawning

We placed about 15 ~~mother shells~~ adults in 20 L fish boxes through which we ran seawater warmed with hotbed wires. The temperature was raised slowly to 15°C. The treated ~~mother shells~~ adults were taken out of the boxes from time to time and we measured the ~~induction~~ spawning rate by counting the individuals ~~having~~ that spawned ~~or spermatized~~ within about 10 hours. In the meantime, we measured the water temperature inside the fish boxes every 30 min.

(3) Tests in spawning control

Using a unit cooler, we ran seawater chilled to 5.0 ~ 7°C from March 30 to May 2 and prevented spawning ~~by~~ of the above ~~mother shells~~ adults contained in the boxes.

(4) ~~Insemination~~ Spawning method

When we noticed females starting to spawn inside the fish boxes following thermal stimulation, we picked them out, transferred them to 30 L panlite tanks filled with filtered seawater and allowed them to continue spawning.

Thereafter, males were induced to ~~spermatize~~ spawn in a separate tank. By mixing suitably the released sperm into the spawning tank, ~~insemination~~ fertilization was achieved.

Following this, washing was carried out every 40-50 min, 5 times after each process with filtered seawater warmed to 12-14°C. Then the temperature was adjusted to 14-15°C and we waited for the progress of ~~early generation~~ development. Selecting the time when most larvae were swimming upwards, we collected only those larvae which swam to the surface and transferred them to a separate tank. We discarded the larvae slow in swimming upwards.

The ascent took place about 24 hours after ~~insemination~~ fertilization. The larvae moving to the surface were reared in the same tank until they reached the D type stage. This took 40 - 45 hours following ~~insemination~~ fertilization.

(5) Method of rearing the free-swimming larvae

We put a 0.3t capacity polyethylene tank in a 1t capacity concrete tank so as to have a double tank. The outer tank was filled with seawater and fitted with 100V 500W vinyl hotbed wires. We adjusted the temperature of the rearing tank to a constant level.

For the rearing, we installed tanks adjusted to 3 levels of temperature: 11 - 13°C, 14 - 16°C and 17 - 19°C, and watched the effect of water temperature upon the growth rate of the free-swimming larvae. For rearing

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seawater, we used water filtered with a haifuressha* and reared in still water. Continuous gentle aeration was carried out.

To change the water, about 3/4 of the rearing seawater was passed every 3 - 5 days through a 100μ screen and discarded with a siphon. Fresh filtered seawater warmed to the same temperature was added. When the larvae reached the settling stage, the entire water was replaced. At the start, the rearing density was 1,000 - 1,300 larvae/L.

~~The feed consisted in~~ Food was Chaetoceros calcitrans and Monochrysis lutherii separated by continuous centrifugation. These were mixed at the rate of 3:1 in cell numbers and feeding was carried out twice a day.

The amounts of ~~feed~~ food were as follows: 3,000 - 4,000 cells per larva per day for larvae of 170 - 180μ or less, 5,000 - 6,000 cells per day for larvae at the intermediate and later periods.

When the free-swimming larvae neared the settling stage, we suspended the fibrous skins of hemp palms in the tank.

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Results

(1) ~~State of spawning induction~~ Artificial Spawning

Graph 1 shows the ~~state of~~ results of artificial spawning ~~induction among the~~ in the females ~~employed~~. The values were highest on March 20. Fig. 2 indicates that the state of maturation of the gonads is such that on March 20, the average value of ($\frac{\text{weight of gonads}}{\text{weight of soft parts}}$ x 100%) was 32.5%. On March 30, the readings dropped to 24.0%. These facts lead us to think that this year, natural spawning in Kawauchi took place from mid-March. At that time, the temperature of the bottom water off Kawauchi was 5.3°C. Artificial Spawning ~~induction~~ becomes

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*Translator's note: meaning uncertain; a trademark?.. (high freshener?...)

possible at a fairly earlier date. In mid-February we were already able to induce spawning ~~or spermatization~~ in 30% of the females and males. The eggs were 80 – 90μ in diameter, spherical and could be easily fertilized. It was rather difficult to obtain fertilization after the start of natural spawning. Of the ~~mother shells~~ adults collected April 26, 56.2% were induced to spawn but the volume of eggs was small and many eggs were deformed.

(2) Tests in spawning control

~~Mother shells~~ Adults which had been under control were transferred on May 2 to fish boxes through which we ran warmed seawater. The temperature was gradually raised to 15°C which stimulated the ~~shells~~ adults. Within 5 hours, 50% of the ~~mother shells~~ adults showed induced spawning as shown in Graph 1. Graph 2 shows that the degree of gonadal maturity was practically the same as at the time of the collection, and we may believe that the control had been effective.

If by this method we effectively control the water temperature, it should be possible to carry out this kind of control for a still longer period.

(3) ~~The feed~~ Food organisms p. 4

Prior to rearing larvae, one should have ~~feed~~ good organisms for the free-swimming larvae. We used Monochrysis lutherii and Chaetoceros calcitrans mixed at the approximate rate of 1 to 3. Flagellates such as Monochrysis lutherii are good ~~food~~ good but unfortunately slow to reproduce. Chaetoceros calcitrans on the other hand reproduces fast and is good ~~feed~~ good for the early period larvae. However, if it is used alone, the larvae never settle even if they reach the attachment period, but remain stationary. We do not know

why, but feeding with Chaetoceros calcitrans alone seems to cause some nutritional insufficiency and no progress toward attachment can be seen.

(4) Rearing of the larvae and their growth ~~progress~~

Table 1 shows the rearing methods and results for the various tanks. Graph 3 shows the different courses of growth.

Good results were observed in all tanks. More particularly, the shell began to expand 8 days after fertilization in the 17 - 19°C high temperature tank. Some individuals were beginning to settle on the 12th day. In the 14 - 16°C tank, umbo ~~expansion was~~ were noted on the 11th and settling was reached on the 15th day. In the 11 - 13°C tank, the umbos began to ~~expand~~ appear on the 14th day and the settling period started around the 18th day.

At the time the umbo begins to ~~expand~~ appear, the length of the shell is 185 - 195μ according to Ito et al. (1964). In this year's rearing, it was 210μ.

~~The~~ Spat reaching the settling period attach themselves lightly to the walls of the container or to the collector with their byssus. Sometimes, they crawl away and settle in another spot. When they reach 250 - 260μ, the marginal shell begins to expand and gradually the individual moves less and less.

According to Ito et al. (1964) the number of days preceding the settling period and following fertilization is 28 -36 with 13 - 17°C water. In our tests, it was about 15 with 14 - 16°C water so that the free-swimming period was practically cut by 1/2.

The yield was about 50% in all tanks from the beginning of the rearing period to the settling period. As seen in Table 1 the results were less good with regard to final settling.

Immediately prior to the settling period in the 11 - 13°C tank where the best results were obtained, the entire water and the rearing tank were simultaneously replaced. As for the 14 - 16°C tank, the tank was replaced after the larvae had already reached a fair development. As a result, the collection rate for the larvae transferred to the new tank was 7.6% and we were able to gather 20,000 settled spats. With regard to the 17 - 19°C tank, there was no tank replacement and the spats were allowed to attach themselves to the tank from the beginning of the rearing.

Thus were we able to shorten the number of rearing days and to obtain good results with respect to survival rate prior to the settling period, and to have a 36.6% seed collection rate with 11 - 13°C tanks. These seem to be the main reasons.

This year, the rearing temperature was very well adjusted. During p. 5 the whole period the variations were maintained within a 1°C range.

In the tests conducted by Ito et al. (1964), the feed concentration in the rearing water was set at 30,000 - 50,000/cc. This year however, we counted the free-swimming larvae every day and fed them 3,000 - 6,000 cells per individual according to their growth. If this amount is converted to rearing seawater concentration, we had with 3,000 - 6,000 cells/cc only 1/10 of the above amount of feed, and we were able to avoid water deterioration due to residual feed.

The collection rate was particularly good when changing the rearing tank immediately prior to settling as with the 11 - 13°C tank. By doing this, we were able to eliminate the dirt on the walls of the old tank which seems to be effective in preserving the quality of the water.

Postscript

The settled spats collected through the above methods are presently accommodated on pearl nets (30 x 30 cm, 2 mm mesh) at the rate of 1,000 - 2,000 individuals per net. Some are suspended directly in the sea (about 20,000) from rafts in front of the center. Some were placed in a 5t indoor tank where they are cultivated and fed (about 100,000; the feed is Phaeodactylum tricornutum) and we are watching their growth and yield.

There are still many problems regarding the period of rearing up to about 1 cm. These will be studied later.

Summary

(1) From February to May 1967, we examined the artificial collection of scallop seed and the maturation of the gonads in scallops~~mother-shells~~.

(2) From mid-February, we were able to obtain mature eggs by inducing spawning through thermal stimulation in ~~mother-shells~~ 2d. Hs gathered from Kawauchi in 1967. Induced spawning took place in 56.2% of the ~~mother shells~~ 2d. Hs in late April but there were many ~~lumps~~ problems and the operation was not effective.

(3) From March 30, April 2, April 12 we used unit coolers to run through the tanks seawater kept cooled at 5.0 - 7.0°C and were able to control spawning. In all cases, induction was noted in 50% of the ~~mother-shells~~ 2d. Hs. The state of gonad maturation showed practically the same values as at the collection time.

(4) For rearing, we prepared tanks whose temperatures had been adjusted at three levels: 11 - 13°C, 14 - 16°C, 17 - 19°C, and we examined the effect of water temperature upon the growth rate of free-swimming larvae.

(5) We started to rear the larvae at a density of 1,000 - 1,300 individuals/L. The ~~feed~~ food was Chaetoceros calcitrans and Monochrysis lutherii with a cell

number ratio of 3:1. They were obtained by centrifugal separation and fed to the larvae twice a day. The amount of feed was calculated so as to give 3,000 – 6,000 cells per larvae, depending on larval growth. Fibrous skins of hemp palm were suspended in the tank to serve as collectors.

(6) After fertilization, it took 18 days to reach the settling stage in the 11 – 13°C tank. In the 14 – 16°C tank, it was 15 days, and only 12 days in the 17 — 19°C tank.

(7) The umbo of the shells ~~expanded to~~ 210μ. At the period of attachment (the size at which the marginal shell begins to grow), it was 250 – 260μ.

(8) The 11 — 13°C tank which had been replaced immediately before the settling period showed a 36.6% collection rate, and we were able to collect about 110,000 settled spats.

Table 1 Rearing results obtained with the free-swimming scallop larvae

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a	b	c	d	e	f	g	h	i	j	k	l
水槽	飼育水温 (℃)	容量 (ℓ)	水槽当りの幼生収容能体数 (個)	幼生収容密度 (ℓ)	受精月日	変態完了までの日数 (日)	変態完了時の生残率及び奇形体数 (%)	付着期までに要した日数 (日)	付着期までの生残数及び(個体数) (%)	採苗稚貝(400～500μ) (個体)	採苗率 (%)
A	11～13	300	300,000	1,000	3月20日 m	14	52	18	40 (個体) (120,000)	110,000	36.6
B	14～16	300	300,000	1,000	〃	11	63	15	50 (150,000)	23,000	7.6
C	17～19	300	390,000	1,300	〃	18	62	12	52 (202,000)	2,000	0.5

(Note) Proportion of kinds of feed
{ Monochrysis lutherii 1
{ Chaetoceros calcitrans 3

Feeding: 3,000 - 4,000 cells per larva with a shell length of 170 - 180μ or less; 5,000 - 6,000 cells per larva at the intermediate and late rearing periods.

Key to Table 1:

a tank
b rearing temperature (°C)
c capacity (L)
d number of larvae per tank (individuals)
e density (L)
f date of fertilization
g number of days before umbo expands (days)
h survival rate and number of individuals at the time the umbo expands (%)
i number of days needed to reach the settling stage (days)
j survival rate and number of individuals reaching the settling stage (individuals %)
k number of spats collected (400 – 500μ) (individuals)
l collection rate
m March 20
n individuals

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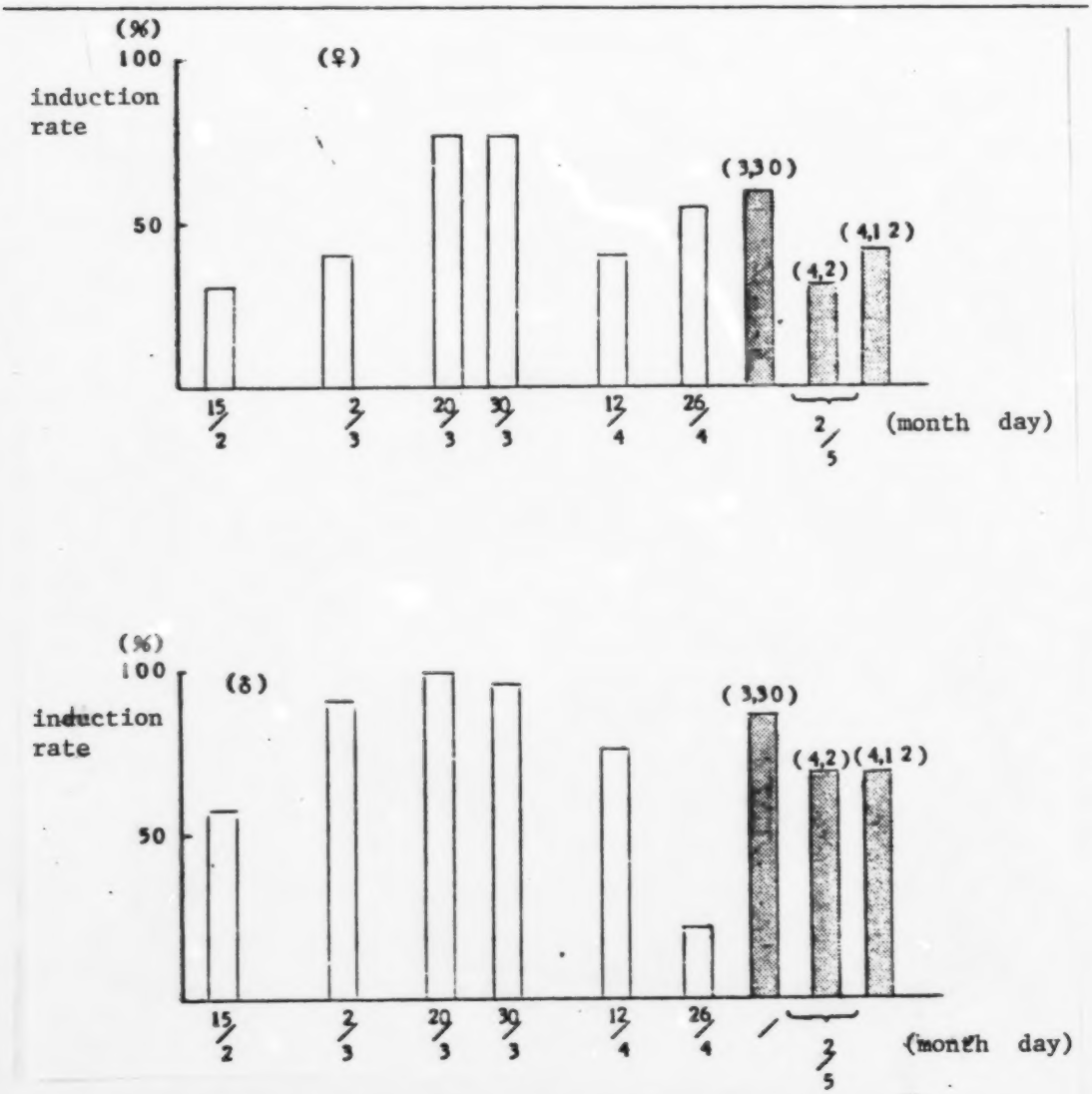

Fig. 1 Seasonal variations in the rate of spawning induction.

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Fig. 1 (cont.)

induction immediately after collection

induction following inhibition (the figures indicate the month and day of collection)

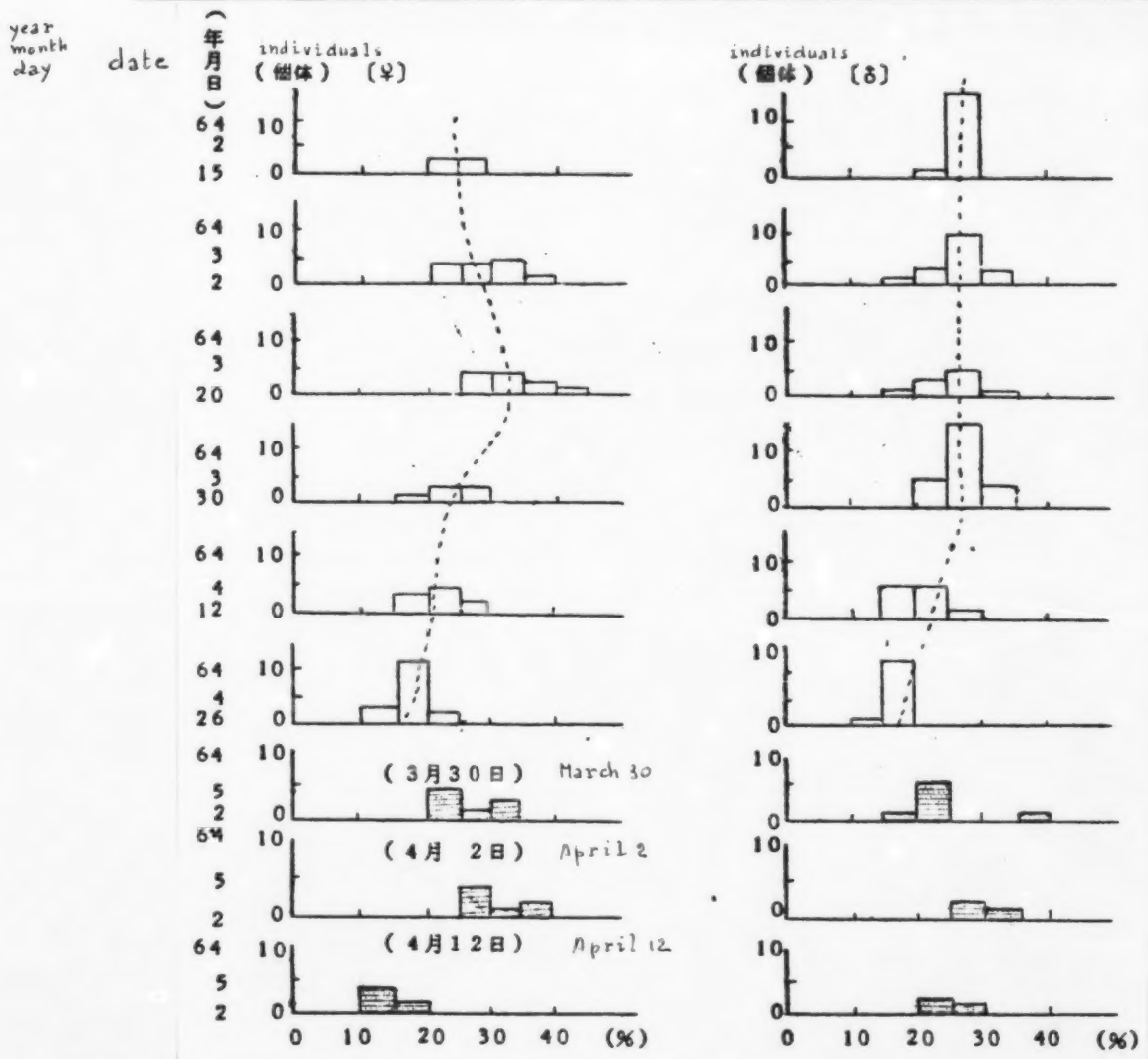


Fig. 2 Seasonal variations of $\left(\frac{\text{weight of gonads}}{\text{weight of soft parts}} \times 100\%\right)$

(Note) induction immediately after collection

induction following control (the figures indicate the month and day of collection.)

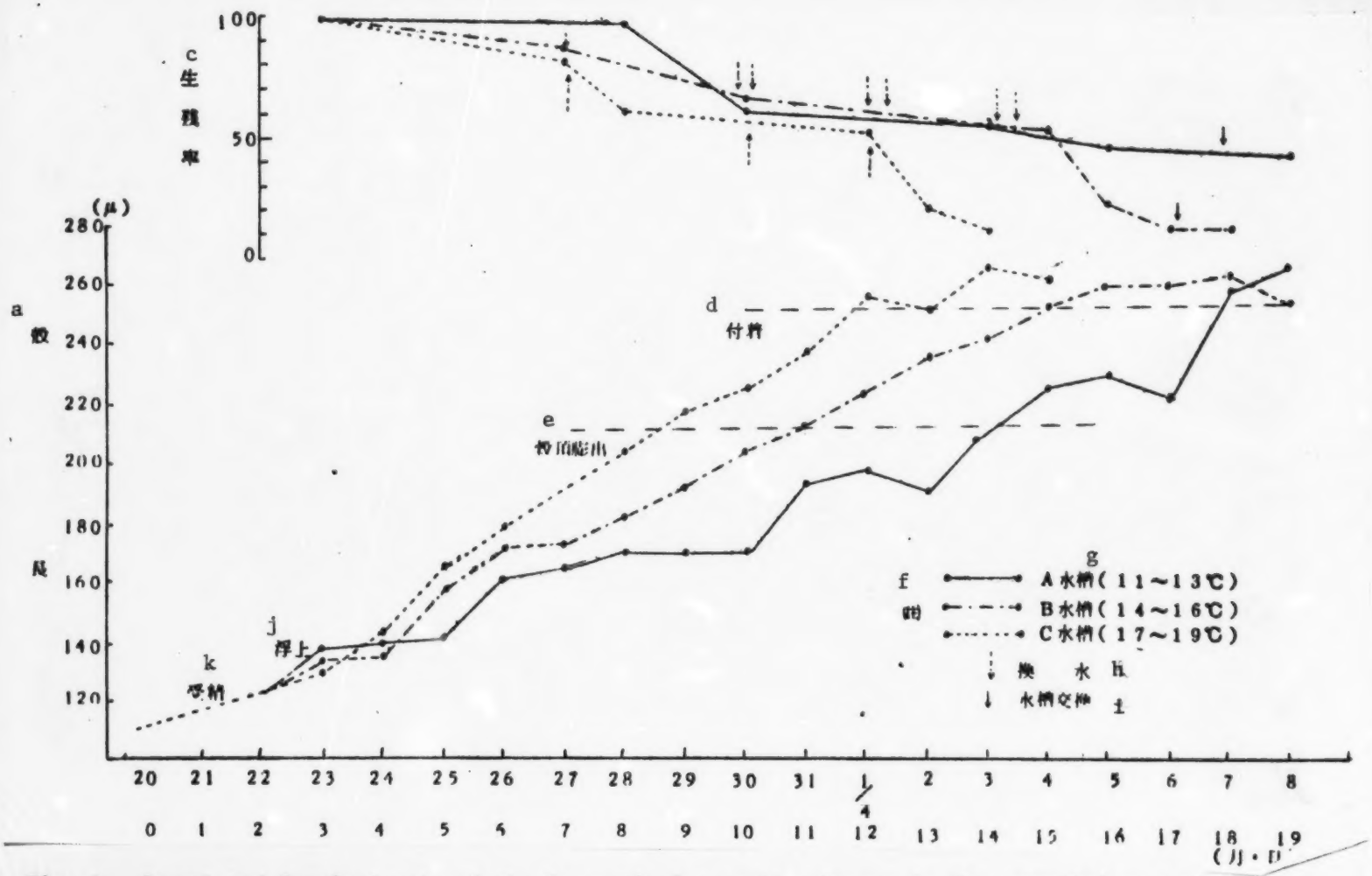
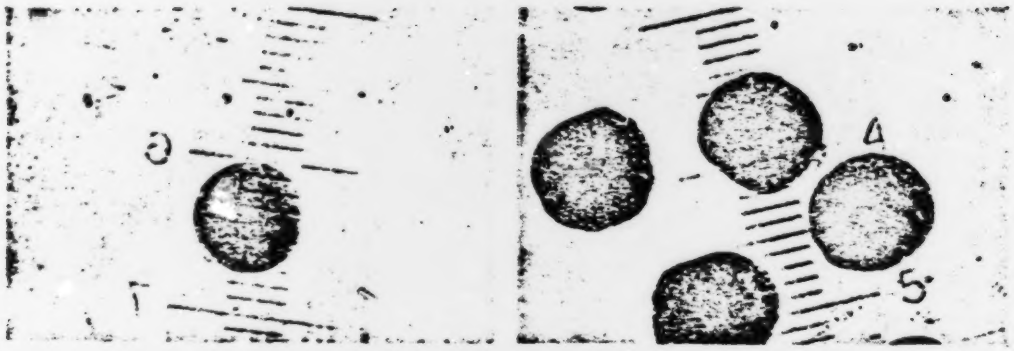


Fig. 3 Growth and Survival rate of the free-swimming scallop larvae in the polyethylene tank

Key: a length of shell b (month - day) c survival rate d settling
e umbo expands f (note) g tank h water change
i tank change j swimming to surface k fertilization



1. fertilized egg
   (polar body formation)

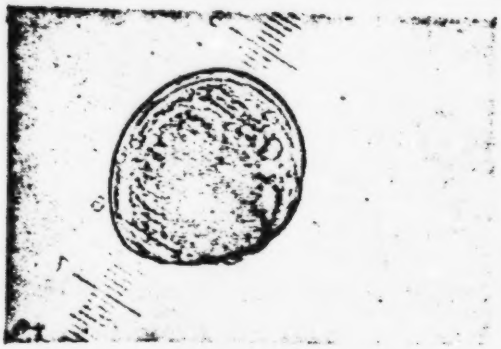
4. blastular stage

2. cellular stage

5. D-type larvae (120μ)

3. cellular stage

6. intermediate period larvae (190μ)



7. umbo expansion stage (260μ)

8. Marginal shell formation immediately after attachment (300μ)

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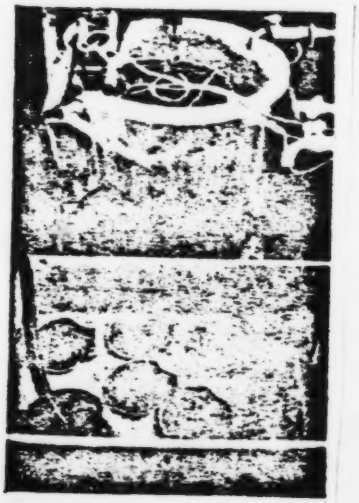
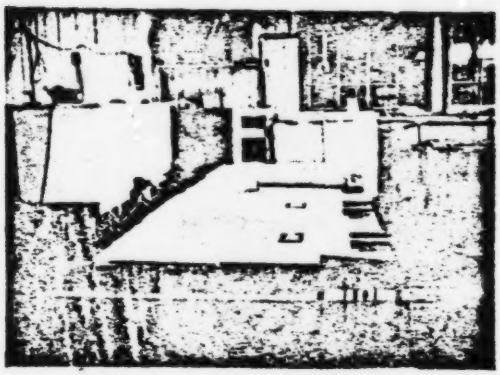
9. crawling spat (700μ)



10. spawning induction

11. rearing prior to ascent

p. 12



12. polyethylene tank used to rear the larvae

13. complete view of rearing room